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Thomas, Binny; Paudyal, Vibhu; MacLure, Katie; Pallivalapila, Abdulrouf; McLay, James; El Kassem, Wessam; Al Hail, Moza; Stewart, Derek

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PHARMACOEPIDEMIOLOGY AND PRESCRIPTION

Medication errors in hospitals in the Middle East: a systematic review of prevalence, nature, severity and contributory factors

Binny Thomas[1,2] · Vibhu Paudyal[3] · Katie MacLure[4] · Abdulrouf Pallivalapila[1] · James McLay[5] · Wessam El Kassem[1] · Moza Al Hail[1] · Derek Stewart[6]

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Abstract

Purpose The aim was to critically appraise, synthesise and present the evidence of medication errors amongst hospitalised patients in Middle Eastern countries, specifically prevalence, nature, severity and contributory factors.

Methods CINAHL, Embase, Medline, Pubmed and Science Direct were searched for studies published in English from 2000 to March 2018, with no exclusions. Study selection, quality assessment (using adapted STROBE checklists) and data extraction were conducted independently by two reviewers. A narrative approach to data synthesis was adopted; data related to error causation were synthesised according to Reason's Accident Causation model.

Results Searching yielded 452 articles, which were reduced to 50 following removal of duplicates and screening of titles, abstracts and full-papers. Studies were largely from Iran, Saudi Arabia, Egypt and Jordan. Thirty-two studies quantified errors; definitions of 'medication error' were inconsistent as were approaches to data collection, severity assessment, outcome measures and analysis. Of 13 studies reporting medication errors per 'total number of medication orders'/ 'number of prescriptions', the median across all studies was 10% (IQR 2–35). Twenty-four studies reported contributory factors leading to errors. Synthesis according to Reason's model identified the most common being active failures, largely slips (10 studies); lapses (9) and mistakes (12); error-provoking conditions, particularly lack of knowledge (13) and insufficient staffing levels (13) and latent conditions, commonly heavy workload (9).

Conclusion There is a need to improve the quality and reporting of studies from Middle Eastern countries. A standardised approach to quantifying medication errors' prevalence, severity, outcomes and contributory factors is warranted.

Keywords Medication errors · Prescribing errors · Error causation · Systematic review · Middle East

Introduction

In 1999, the 'Institute of Medicine' (now the National Academy of Medicine) published the seminal report 'To Err Is Human: Building a Safer Health System' quantifying the scale of harm associated with medical care in the United States (US) [1]. The authors called for coordinated efforts by governments, healthcare providers and consumers and others to promote patient safety, setting a minimum goal of 50% reduction in medical errors by 2004. Despite global advances in healthcare practices, an estimated one in ten patients is still harmed while receiving care [2]. In March 2017, the World Health Organization (WHO) published 'Medication Without Harm, WHO Global Patient Safety Challenge' [3, 4]. It called for action to reduce patient harm which occurs as a result of unsafe medication practices and medication errors. The aim is to 'gain worldwide commitment and action to reduce severe, avoidable medication-related harm by 50% in the next 5 years,

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✉ Derek Stewart
d.stewart@rgu.ac.uk

[1] Medication Safety and Quality Center, Pharmacy Executive Office, Hamad Medical Corporation, PO Box 3050, Doha, Qatar

[2] School of Pharmacy and Life Sciences, Robert Gordon University, Aberdeen AB10 7JG, UK

[3] School of Pharmacy, University of Birmingham, Birmingham B15 2TT, UK

[4] School of Pharmacy and Life Sciences, Robert Gordon University, Aberdeen AB10 7JG, UK

[5] The Institute of Applied Health Sciences, University of Aberdeen, Aberdeen AB25 2ZD, UK

[6] College of Pharmacy, Qatar University, Doha PO Box 2713, Qatar

specifically by addressing harm resulting from medication errors or unsafe practices due to weaknesses in healthcare systems'. One key objective is to 'assess the scope and nature of avoidable harm and strengthen the monitoring systems to detect and track this harm' [3, 4].

A number of published systematic reviews have attempted to quantify medication errors at various stages of the medication use processes of prescribing, transcribing, verifying, administration, dispensing and monitoring [5–21]. These have largely focused on secondary care inpatients, with most reporting errors committed in targeted groups of patients including paediatrics, acute care, older people, mental health and perioperative care. Many of these reviews also reported data on contributory factors leading to errors [6, 9–11, 14, 17, 21]. One key limitation highlighted in many of these reviews is the lack of a standardised approach to defining and measuring errors, limiting the validity of any pooling of data from different studies and different systematic reviews. Furthermore, the very different healthcare structures and processes across the world may limit the generalisability of findings to other contexts. Given the first objective of the WHO challenge, there may be merit in conducting systematic reviews capturing studies from specific contexts to provide the most meaningful data which can be used to inform future strategies and interventions.

Given the differing healthcare systems, ethnicity, culture and work practices of the Middle East, there may be merit in conducting systematic reviews of studies within that geographical area (i.e. Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates and Yemen). In 2013, Alsulami et al. published a systematic review of studies up to and including 2011 on the incidence and types of medication errors in Middle Eastern countries and main contributory factors [10]. While noting that error rates were difficult to compare between studies due to being expressed differently, prescribing errors ranged from 7.1% of prescriptions in a teaching hospital to 90.5% of prescriptions in a primary healthcare centre. Poor knowledge of medicines was identified as a contributory factor for errors by doctors and nurses.

One limitation of this review was the lack of any theories of error causation in the synthesis stage. Incorporation of theory in primary studies or systematic reviews will yield findings which provide more comprehensive coverage of the key influential factors. The most commonly used and cited theoretical framework in this field is Reason's Accident Causation model. This model groups error causes as follows:

1. Active failures which are unsafe acts committed by people who are in direct contact with the patient or system. They take a variety of forms including slips and lapses (errors in task execution), mistakes (errors in planning) and procedural violations (rule breaking).
2. Error-producing conditions which can have adverse effects of error-provoking conditions within the local workplace (e.g. time pressure, understaffing, inadequate equipment, fatigue and inexperience).
3. Latent failures which arise from decisions made by policy makers, leaders and top-level management [22].

Furthermore, the review highlighted that published papers from Middle Eastern countries were relatively few and generally of poor quality. Given the advances in healthcare in recent years, an updated systematic review incorporating error theory is warranted.

The aim of this systematic review was to critically appraise, synthesise and present the available evidence of medication errors amongst hospitalised patients in Middle Eastern countries, specifically prevalence, nature, severity and contributory factors.

Methods

The systematic review protocol was developed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guidelines [23] and registered with the International Prospective Register of Systematic Reviews (PROSPERO, CRD42015019693) [24].

Inclusion and exclusion criteria

Primary research studies of any design conducted in hospital settings in the Middle East (as defined in the introduction) which quantified medication errors (i.e. prescribing, administration or dispensing errors) published as full papers in English from 2000 to the end of March 2018 were included in the review. Studies which reported error nature, severity or associated causative factors were also included. Studies of adverse drug events which were not classified as errors were excluded, as were review articles, letters, opinion papers, editorials and conference abstracts.

Search strategy

The search was conducted in Cumulative Index of Nursing and Cumulative Allied Health Literature (CINAHL), Embase, Medline, Pubmed and Science Direct. Search terms (title, abstract, text, keyword) were (medic* OR prescrib* OR dispens* OR administ*) AND (error* OR incident* OR mistake*) AND (Middle East OR Bahrain OR Egypt OR Iran OR Iraq OR Israel OR Jordan OR Kuwait OR Lebanon OR Oman OR Palestine OR Qatar OR Saudi Arabia OR Syria OR Turkey OR United Arab Emirates OR Yemen). The reference lists of all identified papers were reviewed to identify additional studies.

Screening

Screening of titles (BT, DS), abstracts (BT, DS) and full papers (BT, DS) was independently performed by two reviewers, with disagreements resolved by consensus and referred to a third reviewer (KM) whenever required.

Assessment of methodological quality

Papers were independently assessed for methodological quality by two reviewers (BT and one of DS, VP, AP, JM, WEK, MAH) with disagreements resolved by consensus and referred to a third reviewer whenever required. The STROBE checklist (STrengthening the Reporting of OBservational studies in Epidemiology) was adapted as a quality assessment tool [25]. For all study designs, STROBE criteria retained were those relating to bias with addition of criteria specific to medication errors (e.g. error definitions). For qualitative studies, credibility and dependability replaced validity and reliability, and transferability replaced generalisability.

Data extraction

A bespoke data extraction tool was developed and piloted to extract the following: authors, country of publication/study, year of publication, study population, setting, recruitment, error quantification, nature of errors, error severity and contributory factors. Data extraction was also performed by two independent reviewers, as per quality assessment.

Data synthesis

Previous systematic reviews have highlighted the heterogeneity of studies in terms of error definitions, methods of measurement and outcome measures [5–21]; hence, a narrative approach to data synthesis was selected a-priori. Data related to error causation were synthesised using Reason's Accident Causation model as a theoretical framework in terms of active failures, error-producing conditions and latent failures [22].

Results

Study screening

Database searching and review of reference lists yielded 452 articles, 110 of which were duplicates and excluded. Review of titles and abstracts excluded 213 papers with full-paper review excluding a further 79. Fifty papers were included in the quality assessment stage. The PRIMSA flowchart is given in Fig. 1. Of the fifty studies, 48 were of a quantitative, cross-sectional design and two were qualitative in nature.

Quality assessment

Of the 50 studies, none met all 11 STROBE-related quality assessment criteria. Thirteen studies (26%) met eight or more criteria, 21 (42%) between five and seven criteria and the remaining 16 (32%) meeting four or less. Key limitations centred on lack of justification for the method of sampling and sample size, and not adequately considering issues of data validity and reliability (quantitative studies) and trustworthiness (qualitative studies). Supplementary Table 1 gives the findings of the quality assessment processes.

Characteristics of included studies

Almost half of the studies were conducted in Iran ($n = 23$, 46%), followed by Saudi Arabia ($n = 10$, 20%), Egypt and Jordan ($n = 5$ each, 10%), Turkey ($n = 2$, 4%) and one each (2%) from Israel, Qatar, Yemen, Palestine and Lebanon. None of the studies reported data from more than one country. Two thirds ($n = 33$, 66%) were conducted in university-affiliated or academic hospitals, one fifth ($n = 10$, 20%) tertiary care non-teaching hospitals and only three (6%) in general hospitals. Three studies (6%) did not state the type of hospital and one (2%) reported an analysis of a national online database. Within each hospital, a range of specific patient groups was targeted, mostly adults, and the most common types of wards chosen were intensive care units.

The definition of medication errors (or sub-categories of medication errors) was inconsistent. In the 50 studies, 17 different definitions were given, differing in wording and content. The most widely used was that of the US National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) [26]. Ten studies (20%) adopted non-standardised definitions from previous studies or provided their own definition. Three studies (6%) used the definition of medication errors as per Aronson et al. [27]. Two studies (4%) on prescribing errors used the definition of the American Society of Health-System Pharmacists [28]. One study each used definitions provided by Dean et al. [29] and the Institute of Medicine [30]. Twelve studies (24%) did not provide any definition of either medication errors or the sub-category being reported.

Quantifying medication errors

Of the 32 studies quantifying medication errors, the most common methods of data collection were via review of medication charts or records (prescribing, dispensing and administration) ($n = 11$, 31%) or by analysis of data from an error or incident monitoring system ($n = 9$, 28%). Only one study employed multiple approaches to data collection. Data collection periods ranged from 20 days to 2 years. Data extraction of the 32 studies is provided in Supplementary Table 2.

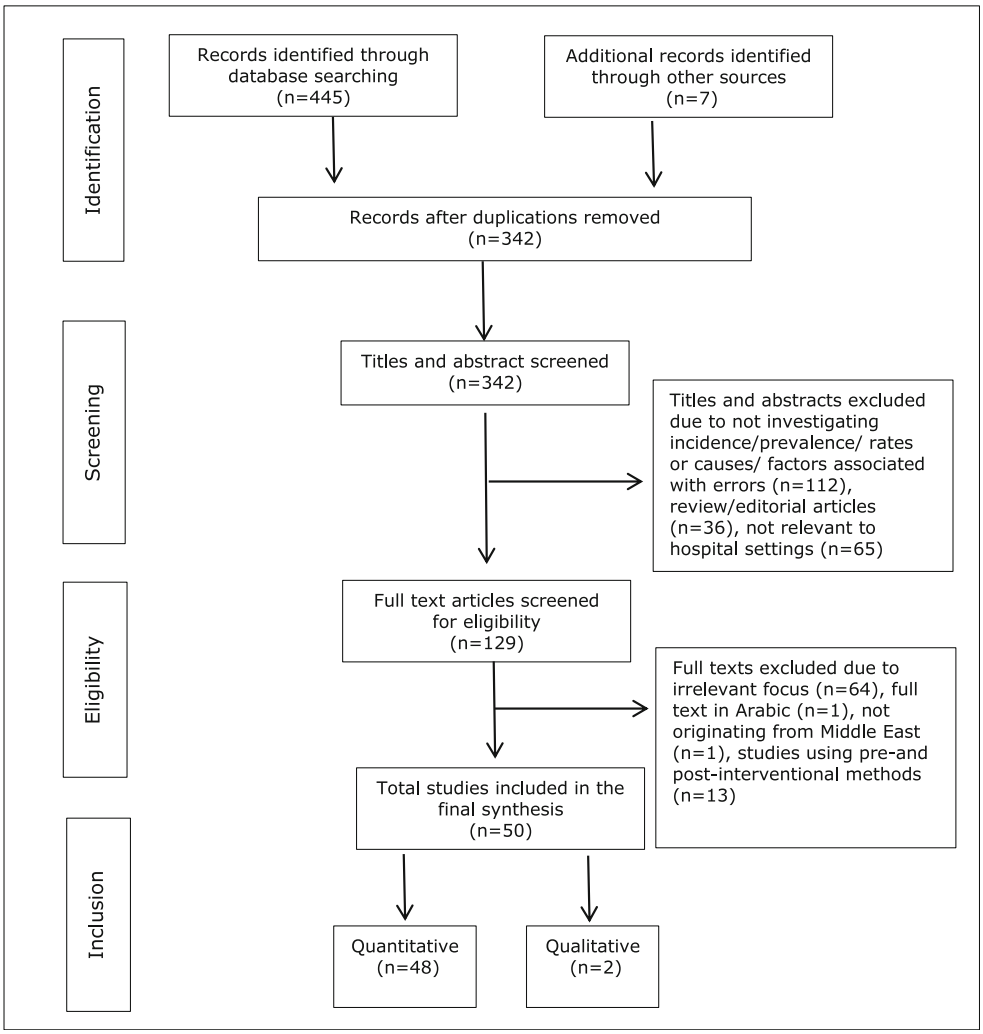

Fig. 1 PRISMA flowchart describing systematic review search and study selection

Inconsistencies in definitions of 'medication error', 'prescribing error' etc., together with the vast range of approaches to data collection and presentation of findings, limited pooling of data hence a narrative approach to data synthesis was employed. Almost half of the studies ($n = 32$, 47%) quantified 'medication errors' in general, with fewer solely reporting 'administration errors' ($n = 7$, 22%) or 'prescribing errors' ($n = 6$, 18%) and one (3%) reporting only transcribing errors. Three studies reported data with combinations of classifications of medication errors.

The specific terms used in the studies to report medications errors varied and eight different denominators were used, the most frequent being 'total number of medication orders' or 'number of prescriptions' ($n = 13$, 40%), followed by 'number of patients admitted' ($n = 6$, 19%) and 'total number of opportunities for errors' ($n = 4$, 12%). One study (3%) each used 'total number of preparations', 'total number of medications dispensed', 'total number of cases/records', 'total number of patient days' and 'total number of reports'. Four studies (13%) did not specify the denominator.

Given this marked heterogeneity, it was not possible to make valid comparisons of the outcome measure of prevalence. Even in studies which used the same outcome measure, the error definitions and methods of measurement varied considerably. The following results should therefore be interpreted with caution.

Of the 13 studies reporting medication errors per 'total number of medication orders'/'number of prescriptions', the median across all studies was 10% (IQR 2–35%). The rates varied from 0.18 to 56 per 100 medication orders'/'number of prescriptions'. Of the six studies reporting 'number of patients admitted', the median was 28% (IQR 1–35%), varying from 0.15 to 40 errors per 100 patient admissions.

Nature and severity of medication errors

Almost all studies (31/32, 97%) provided data regarding the nature of the errors. For prescribing errors, the most commonly reported included errors of omission, wrong drug, wrong dose, wrong route, incomplete order, wrong duration, drug-

drug interaction and wrong patient. Studies reporting administration errors were largely related to wrong administration time, wrong administration route and wrong infusion rate.

Fourteen studies (43%) reported the specific medications most commonly associated with errors. Most frequently reported therapeutic groups included anti-infectives for systemic use, drugs used for alimentary tract and metabolism and cardiovascular drugs.

Thirteen studies (40%) reported error severity, with eight categorising according to the NCCMERP Index [26]. These studies, however, provided very little methodological detail on the application of the index, specifically assessment of inter-rater reliability. In five studies, the most common category was B (near miss), with C (error occurred and reached the patient but with no harm) in two studies and E (error occurred and may have contributed to or resulted in temporary harm and required intervention) in one study.

Contributory factors

Twenty-four studies (48%) from six Middle-Eastern countries reported causes or contributory factors leading to medication errors. Approaches to data collection were largely based on questionnaires (15/24, 63%), data from incident reporting systems ($n = 4$, 17%), direct observation of practice ($n = 2$, 8%), semi-structured interviews ($n = 2$, 8%) and retrieval of information from patient medical records ($n = 1$, 4%). A total of 3919 health professionals were involved in these 24 different studies. Notably, none of these 24 studies used any theory (e.g. behavioural, organisational) in the processes of data collection or analysis. As described in the methods section, findings from these 24 studies were categorised according to Reason's Accident Causation model [22] (Table 1), and synthesis of the categories is provided in Table 2. Contributory factors most commonly reported were active failures, largely slips, lapses and mistakes; error-provoking conditions, particularly those relating to lack of knowledge and insufficient staffing levels and latent conditions, most commonly heavy workload. Error-provoking conditions such as lack of experience, poor documentation and look-alike drugs, or latent conditions of issues relating to a blame culture were rarely reported.

Discussion

Statement of key findings

Heterogeneity in medication error definitions and scope, differences in methods of data collection and units of analysis of the studies included in this review limited data pooling. Most frequently reported was the percentage of medication errors per total number of medication orders with a median across all studies of 10% (IQR 2–35%). Prescribing errors were the most common type of errors reported, with dose-related errors being most prevalent. Contributory factors associated with medication errors were multifactorial. Synthesis of findings according to Reason's Accident Causation model identified that active failures (slips, lapses and mistakes) were most commonly reported followed by error-provoking conditions (e.g. lack of knowledge, insufficient staffing), with latent failures (e.g. heavy workload) least reported.

Strengths and weaknesses

There are several strengths to this review. The protocol was developed according to the standards of PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols [23], registered in the PROSPERO database [24], and the systematic review reported according to PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) criteria [55]. The synthesis adopted a theory-driven approach based on Reason's Accident Causation Model [22], which could subsequently facilitate the development of interventions. There are, however, several weaknesses; hence, the review findings should be interpreted with caution. Restricting the search to the English language and excluding those written in regional languages of Arabic or Persian may have limited retrieval of potentially relevant studies. It is, however, worth noting that English is the preferred language of most professional organisations in the Middle East.

Interpretation of key findings

Although there has been an increase in the number of medication errors studies originating from Middle East over the last few years, two thirds were from Iran and Saudi Arabia with none from eight countries. While the reasons for the lack of studies in other countries are unknown, this does have implications for the generalisability and transferability of review findings and conclusions. Furthermore, there was a lack of studies employing a qualitative approach to explore contributory factors of errors.

The majority of studies had key limitations in study design and lacked transparency in reporting key study details. Authors should be encouraged to adopt standardised reporting checklists available from the EQUATOR (Enhancing the QUAlity and Transparency Of health Research) network [56]. This international network aims to 'improve the reliability and value of published health research literature by promoting transparent and accurate reporting.' An example is the STROBE checklist (Strengthening the Reporting of Observational Studies in Epidemiology) for reporting observational studies [25].

Table 1 Classification of medication error contributory factors

Author(s), year, country	Methodology	Setting, participants, number	Classification of contributory factors as per Reason's Accident Causation model [22]		
Abdar et al. 2014, Iran [31]	Cross-sectional survey	Setting—4 academic hospitals Participants—nurses No. of participants—238	Error-producing conditions • Insufficient staff • Nurse fatigue • Illegible handwriting • Nurse workload		Latent failures • Supervisory issues • Not considering nurses' views
Ali et al. 2017, Saudi Arabia [32]	Retrospective analysis from incident reporting system	Setting—tertiary care hospital Participants—not relevant No. of participants—not relevant	Active failures • Slips—look-alike sound-alike medications	Error-producing conditions • Miscommunication of drug orders	Latent failures • Lack of educational activities
Alshaikh et al. 2013, Saudi Arabia [33]	Retrospective analysis from incident reporting system	Setting—academic hospital Participants—not relevant No. of errors reported—949 Duration—1 year	Error-producing conditions • Lack of knowledge • Illegible handwriting		Latent failures • Performance deficit
Al-Shara et al. 2011, Jordan [34]	Cross-sectional survey	Setting - NS Participants—nurses No. of participants—126	Active failures • Slips—sound alike • Mistake—prescribing wrong dosage • Violation—using abbreviations		Error-producing conditions • Heavy workload • Unfamiliarity of nurses with patients' medical conditions • Unfamiliarity with the use of medications
Al-Youssif et al. 2013, Saudi Arabia [35]	Cross-sectional survey	Setting—government hospital Participants—nurses No. of participants—253	Active failures • Lapse—dispensing wrong drug • Mistake—wrong packaging • Violation—poor adherence to protocol	Error-producing conditions • Illegible prescription • Poor communication	Latent failures • Pharmacists not available 24 h
Al-Tehewy, et al. 2016, Egypt [36]	Prospective observational study	Setting—academic hospital Participants—nurses No. of participants—28	Error-producing conditions • Heavy workload • Patient condition (illiteracy, elderly)		Latent failures • Poor staffing • Lack of policy and procedures • Low commitment of hospital administration towards patient safety
Bagheri-Nesami et al. 2015, Iran [37]	Cross-sectional survey	Setting—12 academic hospitals Participants—nurses No. of participants—190	Active failures • Slips—selecting wrong medication • Lapse—failed to put correct labels on medications • Mistake—delivered incorrect medication doses	Error-producing conditions • Physicians' medication orders illegible • Many patients receiving similar medications • Limited knowledge of medications	Latent Failures • poor communication • Limited access to medication information. • Medication experts not available.
Cheragi et al. 2013, Iran [38]	Cross-sectional survey	Setting—academic Participants—nurses No. of participants—237	Active failures • Slips—wrong patient, • Lapse—failure to give medication	Error-producing conditions • Large variety of drugs in the medication cabinet • Sound alike medications• Too busy and tired from excessive work (nurses)	Latent Failures • lack of training • lack of staffing

Table 1 (continued)

Author(s), year, country	Methodology	Setting, participants, number	Classification of contributory factors as per Reason's Accident Causation model [22]		
			• Mistake—prescribing wrong dosage and infusion rate • Violation—using acronyms of medication names		
Dibbi, et al. 2006, Saudi Arabia [39]	Retrospective chart review	Setting—general hospital Participants—not relevant No. of participants - 2627	Active failures • Slips—choosing wrong medication (look alike and sound alike)		Error-producing conditions • Lack of knowledge • Performance deficit
Ehsani et al. 2013, Iran [40]	Cross-sectional survey	Setting—academic hospital Participants—nurses No. of participants—94	Active failures • Slips—choosing wrong medication (look alike and sound alike) • Violation—using abbreviated names	Error-producing conditions • Fatigue from hard work• Illegibility • Insufficient pharmacological knowledge	Latent failures • High patient -to- nurse ratio • Insufficient education/training
Farzi et al. 2017, Iran [41]	Semi-structured individual interviews	Setting—academic hospitals Participants—physicians, nurses and clinical pharmacists No. of participants—19	Active failures • Slips—look alike, sound alike • Mistake—incomplete medication orders	Error-producing conditions • Lack of knowledge of healthcare team • Lack of professional communication • Lack of medication reconciliation • Interruption/talking while medication administration • Lack of pharmaceutical knowledge	Latent failures • Lack of monitoring or supervisory mechanisms • Weak professional collaboration between healthcare team • Lack of management decisions • Lack of adequate staffing
Fathi et al. 2017, Iran [42]	Cross-sectional survey	Setting—7 academic hospitals Participants—nurses No. of participants—500	Active Failures • Slips—look alike, sound alike • Mistake—wrong labelling	Error-producing conditions • Inappropriate behavior of patients • Fatigue from hard work • Phone call orders • High number of patients • Noisy environment	Latent failures • Lack of monitoring or supervisory mechanisms • Shortage of nursing staff • Lack of drug information resources
Gorgich et al. 2016, Iran 55]	Cross-sectional survey	Setting—academic hospitals Participants—nurses No. of participants—327	Active failures • Violation—unreadable orders	Error-producing conditions • Fatigue due to high workload • Large number of critically ill patients • Poor physical environment (light, temperature) • Poor communication between team members	Latent failures • Low ratio of nurses to patients • Failure in emphasising the importance of recording and reporting the medication errors • Blame culture
Güneş et al. 2014, Turkey [43]	Cross-sectional survey	Setting—2 government hospitals Participants—nurses No. of participants—243	Active failures • Lapse—physicians not writing drug route • Mistake—prescribing interacting drugs • Violation—physicians not writing the order or not in time		Error-producing conditions • Interruption by telephone etc. while preparing medication • Poor mathematical skills for drug dose calculation
Hammoudi et al. 2017, Saudi Arabia [44]	Cross-sectional survey	Setting—tertiary care hospital Participants—nurses No. of participants—367	Error-producing conditions • Illegibility of patients' records • Wrong medication preparation by pharmacists		Latent failures Low staffing
Mrayyan et al. 2007, Jordan [45]	Cross-sectional survey	Setting—11 government and 11 private hospitals Participants—nurses No. of participants—799	Active failures • Slips—nurses confused by different types and functions of infusion devices • Lapse—nurse fails to check the patient name with medication administration record		Error-producing conditions • Nurses distracted by other patients, co-workers or events on unit
	Cross-sectional survey		Active failures		Error-producing conditions

Table 1 (continued)

Author(s), year, country	Methodology	Setting, participants, number	Classification of contributory factors as per Reason's Accident Causation model [22]		
Mrayyan et al. 2012, Jordan [46]		Setting—academic hospitals Participants—nurses No. of participants—212	• Mistake—inaccurate rate of total parenteral nutrition		• Poor quality or damaged medication labels • Fear of disciplinary actions
Pawluk et al. 2017, Qatar [35]	Retrospective analysis from incident reporting system	Setting—tertiary care hospital Participants—not relevant No. of participants—201	Active failures• Lapse—missing documentation • Mistake—error in calculation • Violation—improper use of hospital protocol		
Pazokian et al. 2014, Iran [47]	Semi-structured individual interviews	Setting—academic hospital Participants—nurses No. of participants—20	Active failures • Mistake—prescribing wrong medications	Error-producing conditions • Poo documentation • Poor knowledge	Latent failures • Lack of attention of managers to staff physical and psychological issues leading to decrease in nurses' motivation • Risk management strategies insufficient
Shahrokhi et al. 2013, Iran [48]	Cross-sectional survey	Setting—academic hospitals Participants—nurses No. of participants—150	Active failures • Mistake—incorrect transcription	Error-producing conditions • Excessive workload• Inadequate pharmacological knowledge • Shortage of time	Latent failures • Low nurse to patient ratio • Inadequate number of staff in each working shift • Similar drug packing
Shehata et al. 2015, Egypt [49]	Retrospective analysis from incident reporting system	Setting—government and private hospitals Participants—not relevant No. of participants—1200 reports	Active failures • Lapse—lack of documentation	Error-producing conditions • Lack of knowledge and experience • Excessive workload and distractions • Incomplete prescribing instructions • Illegible handwriting	Latent failures • Lack of drug information resources
Shohani et al. 2018, Iran [50]	Cross-sectional survey	Setting—academic hospital Participants—nurses No. of participants—120	Error-producing conditions • Lack of awareness of drug • Fatigue and workload • Lack of patient information • Noisy working environment • Heavy work load	Latent failures • Lack of motivation amongst nurses • Lack of drug protocol • Lack of training	
Toruner et al. 2012, Turkey [51]	Cross-sectional survey	Setting—4 tertiary care hospitals Participants—nurses No. of participants—124	Active failures • Mistake—reading the prescription in wrong way	Error-producing conditions • Long working hours• High patient–nurse ratio • Lack of patient information	Latent failures • Unavailability of medications in appropriate forms • Poor work environment
Vazin et al. 2012, Saudi Arabia [52]	Prospective observational study	Setting—academic hospitals Participants—patients No. of participants—38	Active failures • Slips—memory lapses • Lapse—faulty dose checking (missing) • Mistake—preparation error • Violation—violating hospital rules	Error-producing conditions • Lack of drug knowledge • Lack of interaction with other services • Lack of patient information	Latent failures • Poor drug stocking and delivery

Table 2 Synthesis of causative factors

Author(s), year, country	Active failure				Error-provoking conditions						
	Slip	Lapse	Mistake	Violation	Lack of knowledge	Insufficient staff	Patient condition(s)	Poor communication	Lack of experience	Distractions	Look alike drugs
Abdar et al. 2014, Iran [31]						✓					
Ali et al. 2017, Saudi Arabia [32]	✓							✓			
Alshaikh et al. 2013, Saudi Arabia [33]					✓						
Al-Shara et al. 2011, Jordan [34]	✓	✓		✓	✓				✓		
Al-Tehewy, et al. 2016, Egypt [36]						✓	✓				
Al-Youssif et al. 2013, Saudi Arabia [53]		✓	✓	✓		✓		✓			
Bagheri-Nesami et al. 2015, Iran [37]	✓	✓	✓		✓						
Cheragi et al. 2013, Iran [38]	✓	✓	✓	✓		✓				✓	✓
Dibbi, et al. 2006, Saudi Arabia [39]	✓				✓						
Ehsani et al. 2013, Iran [40]	✓				✓	✓					
Farzi et al. 2017, Iran [41]	✓		✓		✓	✓		✓		✓	
Fathi et al. 2017, Iran [42]	✓		✓			✓		✓		✓	
Gorgich et al. 2016, Iran [54]				✓		✓	✓	✓			
Güneş et al. 2014, Turkey [43]		✓	✓	✓	✓					✓	
Hammoudi et al. 2017, Saudi Arabia [44]						✓					
Mrayyan et al. 2007, Jordan [45]	✓	✓								✓	
Mrayyan et al. 2012, Jordan [46]			✓								
Pawluk et al. 2017, Qatar [35]		✓	✓	✓							
Pazokian et al. 2014, Iran [47]			✓		✓			✓			
Shahrokhi et al. 2013, Iran [48]			✓		✓	✓					✓
Shehata et al. 2015, Egypt [49]		✓			✓						
Shohani et al. 2018, Iran [50]					✓	✓	✓			✓	
Toruner et al. 2012, Turkey [51]			✓		✓	✓				✓	
Vazin et al. 2012, Saudi Arabia [52]	✓	✓	✓	✓	✓	✓					
Total number of studies	10	9	12	7	13	13	3	6	1	7	2

Author(s), year, country	Error-provoking conditions		Latent conditions						
	Poor Documentation	Illegible orders	Heavy workload	Lack of training	Organisation factors	Blame culture	Supervisory issues	Organisational policy issues	Information resource issues
Abdar et al. 2014, Iran [31]		✓	✓		✓		✓		
Ali et al. 2017, Saudi Arabia [32]				✓					
Alshaikh et al. 2013, Saudi Arabia [33]		✓							

Table 2 (continued)

Al-Shara et al. 2011, Jordan [34]			✓						
Al-Tehewy, et al. 2016, Egypt [36]			✓				✓	✓	
Al-Youssif et al. 2013, Saudi Arabia [53]		✓						✓	
Bagheri-Nesami et al. 2015, Iran [37]	✓	✓					✓		✓
Cheragi et al. 2013, Iran [38]				✓					
Dibbi, et al. 2006, Saudi Arabia [39]									
Ehsani et al. 2013, Iran [40]		✓	✓	✓					
Farzi et al. 2017, Iran [41]					✓		✓		
Fathi et al. 2017, Iran [42]							✓		✓
Gorgich et al. 2016, Iran [54]			✓			✓	✓	✓	
Güneş et al. 2014, Turkey [43]									
Hammoudi et al. 2017, Saudi Arabia [44]		✓							
Mrayyan et al. 2007, Jordan [45]									
Mrayyan et al. 2012, Jordan [46]						✓			
Pawluk et al. 2017, Qatar [35]									
Pazokian et al. 2014, Iran [47]							✓	✓	
Shahrokhi et al. 2013, Iran [48]			✓						
Shehata et al. 2015, Egypt [49]		✓	✓						✓
Shohani et al. 2018, Iran [50]			✓	✓					✓
Toruner et al. 2012, Turkey [51]			✓		✓				
Vazin et al. 2012, Saudi Arabia [52]					✓				
Total number of studies	1	7	9	4	4	2	7	4	4

A tick indicates that the specific causitive factor was reported

As noted in previous systematic reviews [5–21], many studies either did not define terms such as 'medication errors', 'prescribing errors' etc. or used non-standardised definitions. There was also variation in the methods used and the duration of data collection. To further advance this field of research, the adoption of standardised definitions and methodologies should be encouraged. This would enable analytical approaches such as meta-analyses and provide more robust and generalisable findings to inform practice.

Few studies reported the severity of errors, often providing little methodological detail. In a systematic review of tools used in error severity estimation, Garfield et al. highlighted that of the 40 tools assessed, only two were deemed to have acceptable validity and reliability [57].

Despite these issues around standardisation, it is evident from this systematic review that medication errors remain prevalent in hospitals in the Middle East. For those reporting medication errors, the median 'total number of medication orders'/ 'number of prescriptions' across all studies was 10% (IQR 2–35% and range of 0.18–56%). While differences in methodology, settings and patient populations limit comparisons to other systematic reviews; these figures are similar to those reported by Alsulami et al. in a systematic review of Middle Eastern studies up to 2011 [10]. The prevalence of medication errors in the Middle East would appear to remain largely unchanged and at a similar level to those reported from around the world [5–21].

None of the 24 studies in this review and only two previous systematic reviews analysed causative factors according to Reason's theory. In a review of prescribing errors in hospitalised patients, Tully et al. reported that the active failure most frequently cited was a mistake due to inadequate knowledge of the drug or the patient. There were issues of lack of training or experience, fatigue, stress, high workload and inadequate communication between healthcare professionals [9]. In a systematic review of medication administration error studies, Keers et al. reported that slips and lapses were the most common unsafe acts [11]. Our synthesis of study findings according to Reason's Theory is similar in that active failures of slips, lapses and mistakes were most common. Error-provoking conditions included lack of knowledge and insufficient staff. It is possible that other contributory factors may have been identified if the primary studies had used Reason's Theory in data collection and analysis. Using a theoretical framework in primary research would ensure that all possible explanations underlying medication errors are identified [58]. Given the accumulation of evidence from this and other systematic reviews, a standardised, theory-informed approach should be adopted. This is fundamental to the key stated WHO objective of assessing and scoping the nature of avoidable medication-related harm [3, 4].

Policy makers, leaders, practitioners and other relevant stakeholders must continue working towards minimising the key-identified contributory factors where possible.

Further research

There is a need for consensus-based research to define and standardise medication error definitions, approaches to data collection and outcome measures. Furthermore, theoretically informed qualitative research which allows in-depth exploration of contributory factors leading to medication errors is warranted. The findings from studies such as these would facilitate the development, testing, evaluation and monitoring of interventions aiming to reduce avoidable medication-related harm. There is evidence that consideration of theory allows comprehensive identification of the key issues to be targeted as part of intervention development leading to more effective and sustainable interventions compared to more pragmatic approaches [58].

Conclusion

While there has been a clear increase in the number of publications from selected Middle Eastern countries, there is need to improve the quality and reporting of studies. A standardised approach to quantifying medication errors' prevalence, severity, outcomes and contributory factors is warranted.

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Vibhu Paudyal reviews conception, protocol design, data collection, analysis, interpretation, reviewing and approving final manuscript.

Katie MacLure reviews conception, protocol design, data collection, analysis, interpretation, reviewing and approving final manuscript.

Abdulrouf Pallivalapila: data collection, analysis, reviewing and approving final manuscript.

James McLay, reviews conception, protocol design, interpretation, reviewing and approving final manuscript.

Wessam El Kassem: data collection, analysis, reviewing and approving final manuscript.

Moza Al Hail: data collection, analysis, reviewing and approving final manuscript.

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